

CLAIMS

What is claimed is:

- 1 1. A sensor for measuring chloride ion concentration in a medium, comprising:
2 a pair of electrodes; and
3 a polymer film imprinted for uptake of chloride ions under alkaline conditions,
4 wherein the film is disposed on an electrode of the pair of electrodes for contact with
5 the medium.
- 1 2. The sensor as recited in Claim 1, wherein the alkaline conditions include a pH range
2 above 7 in the medium.
- 1 3. The sensor as recited in Claim 1, wherein the alkaline conditions include a pH range
2 from about 10 to about 12.65 in the medium.
- 1 4. The sensor as recited in Claim 1, wherein the film comprises methylpyrrole.
- 1 5. The sensor as recited in Claim 1, wherein the film is disposed in contact with the pair
2 of electrodes.
- 1 6. The sensor as recited in Claim 5, further comprising:
2 a source of electric current to a circuit including the pair of electrodes; and
3 a voltmeter to determine a voltage difference between the pair of electrodes in
4 response to the electric current.
- 1 7. The sensor as recited in Claim 5, wherein the film is further disposed to lie between
2 the medium and the pair of electrodes.
- 1 8. The sensor as recited in Claim 5, wherein an electrical conductivity of the film
2 depends on an amount of chloride ions taken up by the film.
- 1 9. The sensor as recited in Claim 5, wherein the film comprises polypyrrole and
2 polystyrene sulfonate.

1 10. The sensor as recited in Claim 5, wherein the film comprises poly-methylpyrrole.

1 11. The sensor as recited in Claim 5, wherein the pair of electrodes comprises gold
2 electrodes.

1 12. The sensor as recited in Claim 5, wherein the pair of electrodes comprises a pair of
2 interdigitated electrodes.

1 13. A sensor for measuring chloride ion concentration in a medium, comprising:
2 a pair of electrodes; and
3 a conductive polymer film imprinted for uptake of chloride ions,
4 wherein
5 the film is disposed in contact with the pair of electrodes,
6 the film is disposed for contact with the medium, and
7 an electrical conductivity of the film depends on an amount of chloride ions
8 taken up by the film.

1 14. The sensor as recited in Claim 13, wherein a measurable change in electrical
2 conductivity occurs for a chloride ion concentration change of less than 0.02 percent by
3 weight in a chloride ion concentration range from about 0.01 percent by weight to about 0.05
4 percent by weight.

1 15. The sensor as recited in Claim 13, wherein a measurable change in electrical
2 conductivity occurs for a chloride ion concentration change of less than 0.01 percent by
3 weight in a chloride ion concentration range from about 0.02 percent by weight to about 0.04
4 percent by weight.

1 16. The sensor as recited in Claim 13, wherein a minimum detectable chloride ion
2 concentration is about 0.00013 percent by weight.

1 17. A sensor for measuring chloride ion concentration in a medium, comprising:
2 a pair of electrodes; and
3 a conductive polymer film imprinted for uptake of chloride ions under alkaline
4 conditions,
5 wherein
6 the film is disposed in contact with the pair of electrodes,
7 the film is disposed for contact with the medium, and
8 an electrical conductivity of the film depends on an amount of chloride ions
9 taken up by the film.

1 18. The sensor as recited in Claim 17, wherein a measurable change in electrical
2 conductivity occurs for a chloride ion concentration change of less than 0.02 percent by
3 weight in a chloride ion concentration range from about 0.01 percent by weight to about 0.05
4 percent by weight.

1 19. The sensor as recited in Claim 17, wherein a measurable change in electrical
2 conductivity occurs for a chloride ion concentration change of less than 0.01 percent by
3 weight in a chloride ion concentration range from about 0.02 percent by weight to about 0.04
4 percent by weight.

1 20. The sensor as recited in Claim 17, wherein a measurable change in electrical
2 conductivity occurs for a chloride ion concentration change of less than 0.02 percent by
3 weight in a chloride ion concentration range above about 0.02 percent by weight in a medium
4 with a pH up to at least 12.65.

21. An apparatus for long term monitoring of chloride ion concentration in a medium, comprising:

- a sensor platform for embedding in a medium;
- a transmitter disposed on the sensor platform for transmitting to an interrogation unit a response signal based on a chloride measurement; and
- a chloride sensor disposed on the sensor platform, which chloride sensor generates the chloride measurement, said chloride sensor comprising
 - a pair of electrodes, and
 - a conductive polymer film imprinted for uptake of chloride ions under alkaline conditions,

wherein

- the film is disposed in contact with the pair of electrodes,
- the film is disposed for contact with the medium, and
- an electrical conductivity of the film depends on an amount of chloride ions taken up by the film.

22. The apparatus as recited in Claim 21, wherein.

- the apparatus further comprises a power module disposed on the platform, which power module is powered by an interrogation pulse transmitted by the interrogation unit; and
- the transmitter and the chloride sensor are powered by the power module.

23. The apparatus as recited in Claim 21, wherein:

- the apparatus further comprises a conductivity sensor disposed on the platform for generating an electrical conductivity measurement of the medium; and
- the response signal is further based on the conductivity measurement.

- 1 24. The apparatus as recited in Claim 23, wherein:
2 the apparatus further comprises a processor disposed on the sensor platform, which
3 processor derives a moisture-corrected chloride measurement based on the
4 chloride measurement and the conductivity measurement; and
5 the response signal is based on the moisture-corrected chloride measurement.
- 1 25. A method for fabricating a sensor for measuring chloride ion concentration in a
2 medium, the method comprising the steps of:
3 depositing an electrode on a substrate;
4 after said step of depositing the electrode, placing the substrate in an electrolyte
5 solution of lithium chloride and methylpyrrole;
6 after said step of placing the substrate in the electrolyte solution, applying cyclic
7 voltammetry to form a polymer film in contact with the electrode.
- 1 26. The method as recited in Claim 25, wherein.
2 said step of depositing the electrode on the substrate further comprises depositing a
3 pair of electrodes on the substrate;
4 the method further comprising, before said step of placing the substrate in the
5 electrolyte solution, performing the step of treating the substrate with a
6 silanizing agent to enhance adherence of a pyrrole species to the substrate
7 between the pair of electrodes.
- 1 27. The method as recited in Claim 26, said step of treating the substrate with a silanizing
2 agent further comprising treating the substrate with a silanizing agent that comprises silica
3 and pyrrole.
- 1 28. The method as recited in Claim 26, said step of depositing the pair of electrodes on
2 the substrate further comprising depositing gold electrodes on the substrate.
- 1 29. The method as recited in Claim 26, said step of depositing the pair of electrodes on
2 the substrate further comprising depositing a pair of interdigitated electrodes on the substrate.

1 30. The method as recited in Claim 25, further comprising, before said step of depositing
2 an electrode on the substrate, performing the step of forming the substrate by depositing
3 silica glass on an alumina ceramic plate.

1 31. A method for fabricating a sensor for measuring chloride ion concentration in a
2 medium, the method comprising the steps of:
3 depositing a pair of electrodes on a substrate;
4 treating the substrate with a silanizing agent to enhance adherence of pyrrole to the
5 substrate between the pair of electrodes;
6 after said step of treating the substrate with a silanizing agent, placing the substrate in
7 an electrolyte solution of lithium chloride and pyrrole;
8 after said step of placing the substrate in the electrolyte solution, applying cyclic
9 voltammetry to form a polymer film in contact with the pair of electrodes.